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Working Group on Science and Technology

Partnerships and Networking for National Capacity-Building

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Executive summary

1. Since the late 1980s, the world economy has been undergoing fundamental changes driven by the rapid globalization of economic, scientific and technological activities and characterized by the emergence of knowledge-based industries. The emergence of knowledge-based industries and the globalization of the world economy are closely interlinked: globalization has brought with it a more intense competitive environment and new requirements for sustained competitiveness. This new competitive environment has fuelled the growth of knowledge-intensive production by increasing scientific and technological interactions, which, in turn, have led to an acceleration in the pace at which new ideas are generated. The need for innovation and the active search for continuous measurable improvements have created an urgent necessity to adjust policies and practices at both the firm and government levels.

2. Globalization has also brought with it new challenges: those without access to knowledge cannot compete globally, and fall even further behind. To face up to the challenges of this new and highly competitive environment, new forms of inter-firm cooperation, including networking and partnering, have evolved. Such interactions have over the past few years become a more and more popular way of conducting business and transfering technology, and the basis for local capacity-building in many countries.

3. These developments, however, have until very recently been largely confined to firms in the developed countries and, increasingly, in the newly industrialized countries (NICs) in Asia and Latin America. Firm-level studies in a wide variety of developing countries show that many firms from East and South-East Asia have succeeded in making large strides in high-technology sectors not only by investing heavily in both human and physical resources but also by forming partnerships with more technologically advanced firms from the North. Anecdotal evidence from success stories in those countries suggests that partnerships have helped firms in those countries to build the technological capabilities and skills needed to penetrate international markets. Given that the process of partnerships and networking relates to the continuing debate on appropriate policies for economic integration and growth in an increasingly global and knowledge-based economy, the recent upsurge in these inter-firm interactions deserves the attention of policy makers and calls for greater analysis of the dynamics and implications of this process at both the national and international levels.

4. It is in this context that the United Nations Commission on Science and Technology for Development (CSTD) decided to focus during the inter-sessional period 1997-1999 on the theme of "science and technology partnerships and networking for national capacity-building". Its Working Group on Science and Technology Partnerships and Networking for National Capacity-Building met in Malta from 28 to 30 September 1998 and addressed a number of important questions related to the process of partnerships and networking, particularly in the developing countries and countries in transition. The Working Group discussed the extent to which these developments have opened up new opportunities for developing countries and countries in transition to build up indigenous capacity and technological capability, especially at the enterprise level. The Working Group also looked at whether the success of NICs in forging alliances and partnerships and in using them to enhance technological upgrading and improving competitiveness can be replicated in other countries. Participants also discussed the question of whether partnerships and networking could be regarded by policy makers and business leaders, particularly in developing countries, as a vehicle to facilitate their efforts to access capital, technology and know-how: Under what conditions do they present opportunities and constraints for firms in developing countries and economies in transition? To what extent do they contribute positively to economic development more broadly? And, finally, if

indeed there are positive elements in the process of networking and partnering, what might national Governments and the international community do to promote this process?

5. The Working Group focused in particular on partnerships and networking in energy and biotechnology, two very important industries vital to economic growth and development in developing countries. In this respect, the Working Group addressed the policy options and practical measures needed to promote technology partnerships and networking for national capacity-building in developing countries and in countries in transition. The Working Group discussed the role of Governments, the United Nations system and non-governmental organizations (NGOs) in promoting the kind of partnerships which foster innovation, sustain competitiveness and enhance the participation of firms from developing countries and economies in transition in the global economy. Experts considered policy instruments to enhance North-South joint business opportunities by facilitating industrial partnerships based on technology transfer and exchange, and joint research partnerships, and by drawing policy lessons from developed countries' experience in technological upgrading.

6. There was overall agreement that, when formed prudently, partnerships and networking could be effective mechanisms for technological development, national capacity-building and market access across a large number of industries. They could assist in the development of competitive indigenous industry and in the mobilization of the necessary resources and technological expertise to upgrade lagging infrastructure. They could also be vehicles, particularly for small and medium-sized enterprises (SMEs), to learn new business and management cultures and to access international markets. They could also provide firms and research institutions from developing countries and countries in transition with opportunities to leverage their own research and development (R&D) activities and enable them to build the credibility necessary to attract the attention of potential partners abroad. However, it was stressed that partnerships and networking, while important, could not be expected to be a panacea for all the problems on the road to economic development. It was also noted that neither the benefits nor the attempts to build successful partnerships were always assured. Much depends on the objectives of the partners and the level of their competence as well as on the macroeconomic and policy environment where the partnership takes place.

7. There was overall recognition that developing countries and countries in transition continue to face certain constraints in their efforts to advance in technology transfer and cooperation, since they lack financial resources and have limited human and institutional capacities. There was agreement that Governments have a crucial role to play in fostering networks and partnerships. The creation of an enabling macroeconomic and policy environment that includes an appropriate legal and regulatory framework, support mechanisms and incentives is vital for inter-firm cooperation. There was also agreement that education, information and basic research have to be a central task of the State. It is also very important that Governments provide support for the development of an adequate infrastructure that helps the continuity of partnerships.

8. The meeting illustrated the close linkages between technology policy issues and the export performance of developing countries. Specific actions are needed from developed countries and from international organizations to support the efforts of developing countries to acquire the technologies, know-how, human resources and institutional structure that would foster their export growth and enable them to "leapfrog" to the path of sustainable development. Experts emphasized the need to improve access to information on R&D and to analyse the impact of networks on the globalization of research and on enhancing innovation potential and technological policies in developing countries and in countries in transition. It was recognized that additional

work needed to be done to develop guidelines and case studies based on lessons learned and best practice from the wide variety of available experiences of networking and partnerships already under way.

9. The meeting was divided into three substantive sessions. The first focused on recent trends in partnerships and networking for capacity-building in all sectors of the global economy. During this session, the Working Group addressed issues such as: the definition and types of science and technology partnerships; general trends in partnering and networking; their scope for capacity-building; the determinants and rationale behind partnerships and networking; and the role of national Governments and policy implications. Alliances, it was noted, took a variety of forms ranging from long-term multi-project partnerships pooling the production, research and marketing facilities of different companies, to joint ventures or multi-company research consortia involving technology cross-licensing and reciprocal marketing activities and to tripartite partnerships incorporating R&D institutions, government agencies and private firms.

10. The second session addressed the issue of energy partnerships and their critical contribution to the provision of energy supplies and services. Participants reaffirmed the importance and linkages of energy not only to the economy but also to current concerns about the environment and sustainable development. It was pointed out that growth in energy consumption was necessary to reduce poverty and improve the quality of life in developing countries, where nearly 2 billion people are without access to electricity and commercial energy. Providing adequate energy supplies and services to meet the energy needs of this large segment of the world's population while at the same time safeguarding the environment will be a major challenge to policy makers worldwide. International collaboration and partnerships in the area of energy technology are among the indispensable mechanisms we need to meet such challenges.

11. The third session focused on biotechnology, which has been, over the past few years, at the forefront of new forms of strategic alliances and partnerships. For many years, the industrialized countries have been witnessing new cooperative relationships in research and new kinds of symbioses between universities, R&D institutions and enterprises, or between otherwise competing enterprises themselves. Local networks of research institutions, firms and users, as well as international biotechnology initiatives, play an important role in building capabilities in developing countries. However, there was concern that developing countries have not been closely involved in the planning and design of most of the biotechnology initiatives in order to take into account local priorities and capabilities. North-South alliances could provide access to new technologies and bring financial gains for the use of the generic resources. South-South partnership agreements and networks could be used to develop specific R&D activities and enhance the quality of production.

1. Introduction

12. In her introductory statement, the Director of the Division on Investment, Technology and Enterprise Development recalled that, in recent years, globalization and trade liberalization have contributed to the integration of markets and to the diffusion of a process of innovation-based global competition among firms. The pressure of global competition has led firms - even traditional rivals - to increasingly engage in partnerships and networking. This development is largely in response to the growing knowledge-intensity of production and the emergence of an innovation-based mode of competition. Firms thus compete not only on price but also on their ability to innovate. The increasing intensity of competition and innovation has led to the shortening of product life cycles and added to the pressures on firms to continuously introduce new and improved products into the market. In the case of high-technology industries, scientific and technical knowledge has become a strategic competitive asset, but even in more traditional industries, such as textiles and garments, food production and fish farming, continuous innovation in product design, management practices and marketing has become the basis for survival and growth of firms in most countries.

13. These challenges have prompted firms to seek partnerships with other firms to pool their resources and to share the costs and risks involved in R&D activities. These developments are obviously of major concern not only to firms in the developed countries but also to firms in developing countries, where the pressure for innovation and adjustment to sustain competitiveness has made it more difficult for them to "catch up", and has led to the erosion of comparative advantage based mainly on low-wage labour. As globalization has put pressure on knowledge-based institutions and firms in developing countries to operate increasingly within market-based economies, more attention will have to be given to mechanisms and approaches that will enhance their capacity to innovate and compete. Partnerships and networking can provide an attractive way to accomplish these goals.

14. While inter-firm cooperation agreements have existed for a long time, they have mostly been one-way relationships as opposed to two-way partnerships, particularly as regards partners from developing countries. Traditionally, these one-way relationships, in the form of licensing agreements or franchising for instance, were formed to transfer knowledge about a product or a process to a licensee for a royalty fee. As they usually involve a partner who is more technologically advanced, the process of technology transfer tended to move predominantly in one direction.[1] Similarly, joint ventures and other production-sharing agreements, particularly in the mineral and petroleum industries, have been in existence since early in this century and have become increasingly significant since the 1960s. These early forms of one-way inter-firm relationships are in the process of being transformed into two-way partnerships. To a large extent, this transformation is the result of rapidly changing competitive conditions in many industries. This is particularly pronounced with regard to inter-firm technology and R&D agreements in knowledge-intensive industries, such as information technology.[2] Data in the MERIT/UNCTAD database show that the share of two-way partnerships involving a firm from developing countries in information and technology agreements rose from 22 per cent in the 1980s to 55 per cent in the 1990s. This upsurge deserves the attention of policy makers and suggests there is a need for greater analysis of the dynamics and implications of the processes involved at both the national and international levels. It is in this context that the CSTD decided to make scientific and technological partnerships and networking the main substantive theme of its fourth session.

2. Partnerships and networking: definitions, rationale and trends

15. The Working Group defined partnership as a two-way relationship which entails a long-term commitment between two or more parties whose objective is to share knowledge, enhance technological capabilities, foster innovation and strengthen competitiveness. Partnerships of this kind involve interaction and mutual dependency and entail the sharing of risks and costs as well as market access and power.

16. Networks come in many forms, representing a broad spectrum of collaboration agreements. Usually, a network consists of a group of institutions or associations whose aim is to enhance capacity to conduct research and improve training and education through interaction. Partners benefit from their involvement in the network by gaining access to new ideas, methodologies, information and learning materials. They also benefit from networks by collaborating with others in training and research programmes and by sharing experiences. Networks link institutions and enterprises that are willing to share experiences, research results, skills and information in order to gain knowledge and improve innovation. A network has to be efficient to compete successfully against other organizational forms. It also has to be attractive if participants are to stay in and invest in it. Gains have to be equitably shared to promote trust and to foster loyalty. One of the main characteristics of a network is that it does not require geographical proximity of the parties involved.

17. The experts noted that the reasons for forming partnerships differ depending on the type of sector involved and on the objectives of the parties. In general, however, the most important incentives motivating firms to engage in forming partnerships are the need to build and upgrade technological capacity, stimulate innovation and improve competitiveness and market access. Other factors motivating companies to enter into cooperation agreements are the sharing of costs and market risks, the greater efficiency resulting from economies of scale and the possibility of accessing new financial resources and finding markets with fewer regulatory barriers.

18. In discussing the role of partnerships and networking in capacity-building, the experts noted that the few available studies involving developing countries show that many partnerships and networks have been very important in fostering technological upgrading and improving the quality of products across a wide range of industries, particularly in the countries of South-East Asia. For developing countries, the acquisition of advanced technology, whether through partnerships or through foreign direct investment (FDI), has been instrumental in building their own technological capabilities to break into export markets and then maintain market share. On the other hand, many partnerships have been ineffectual, particularly when local needs, priorities and capabilities are not taken into account. One expert also noted that, in trying to establish partnerships with foreign partners, some developing countries face constraints resulting from the rules imposed by certain countries on both domestic and non-domestic firms seeking partners in those developing countries.

19. In their presentations, the experts noted that the last few years have seen a substantial increase in networks and partnerships across a wide range of industries. The bulk of partnerships, however, remain confined to firms from developed countries. The literature shows that, since the early 1980s, inter-firm alliances have primarily been concentrated in high-tech industries, such as information technology, and, increasingly, in biotechnology and advanced materials, mainly in developed countries. Anecdotal evidence shows that, since 1990, there has been a steady increase in South-South and North-South technology partnerships involving diverse actors such as enterprises, academic institutions and R&D centres. The number of reported partnerships in information technology - mainly in telecommunications - involving at least

one participant from a developing country grew faster than partnerships involving partners from developed countries only. In addition to the larger and more technologically advanced developing countries such as Brazil, China, India, Malaysia and the Republic of Korea, a wider spectrum of small countries have also become viable technology partners.

3. Capacity-building through partnerships and networking

20. Surviving in a competitive economy depends increasingly on knowledge, innovation, management and technological capabilities. Experts stressed that knowledge-based activities require the building of multidisciplinary institutions that support local industries by providing essential knowledge and expertise. A trained workforce can make the difference between the success and failure of any partnership. The transfer of advanced technology may be of little use if domestic technical and managerial skills are not available to adapt, operate and manage it. For this reason, building indigenous capacity has become the basis of economic success and export performance. The experience of the countries of South-East Asia vividly demonstrates the importance of technological capacity in sustaining export growth that was originally based on labour cost advantages.

21. Experts also noted that while Governments in developing countries have long acknowledged the critical importance of capacity-building, many have done little to commit adequate investment to the development of training programmes that promote technological capabilities. However, over the past decade a number of countries in Asia and Latin America, and more recently in Africa, have made conscious efforts to build up technological capabilities that would help them not only catch up but also keep up with today's international competition.

22. In discussing the process of technological capacity-building, experts emphasized that partnerships and networking should not be considered as ends in themselves. They should not be expected to be more than they are: they are only two of the many possible ways of building technological capability. Partnerships may complement the efforts of developing countries to acquire technology and build capacity through other means, most notably FDI. However, like FDI, partnerships tend to be much more concentrated in countries that have already committed large investments to both infrastructure and human resource development and that have achieved a certain degree of domestic technological capability and market maturity. In many developing countries, the reality may be very different; they often lack the capacity to form strategic alliances and compete strategically. The competitive environment is also usually weak because of restrictive regimes, which tend to shelter inefficient local firms from international competition. In such an environment, it is very difficult to conceive of effective partnering and networking unless there is strong support and commitments from local Governments as well as from donor countries. Government intervention may be necessary to provide incentives to existing enterprises to build up and upgrade capabilities and to develop complementary capabilities through education and training. It may also facilitate linkages between universities and industries to disseminate information and technological innovation. Donations made by the Governments and NGOs of developed countries can also play a vital role in assisting national efforts to build the institutional capacity to train workers from local enterprises in the use of advanced technology and in assessing its impact.

4. The role of Governments in fostering partnerships and networking

23. The Working Group reaffirmed the important role that Governments can play in fostering partnerships and networking. Government policies are indeed essential not only to the attraction of FDI but also to inter-firm agreements, including those on R&D and related high value-added activities. Government

policies can also hinder potential partnerships by sending confusing signals or by simply discouraging them. The use of incentives such as the elimination of trade barriers, the opening up of markets and the reduction of corporate taxes is likely to contribute significantly to the promotion of partnerships and networking.

24. The initiation and establishment of partnerships, particularly those involving firms from developing countries, is not a spontaneous process. It involves a web of complex factors, whether legitimate or not, which may determine the scope of the process and its success or failure. Experiences with inter-firm technology cooperation in industrialized and industrializing countries reveal that support from Governments, both through direct and indirect measures to foster partnerships, is fundamental. The question is, what can the Governments of developing countries do to attract viable technology partners and foster partnerships? A useful starting point in attempts to answer this question is to examine the process involved in initiating and establishing partnerships.

25. The findings of case studies involving inter-firm technology collaboration in the countries of the Southern Common Market (MERCOSUR) presented by one of the experts show that government support is likely to be more crucial to the establishment of networks and partnerships in developing countries and in economies in transition, where most firms, especially SMEs, lack the technological capabilities and financial resources needed to attract potential partners and create successful partnerships. Even in situations where the firms themselves are quite advanced technologically and are able to form a partnership, there are likely to be other factors that ultimately determine the establishment and fate of the partnership.

26. There was consensus that the role of Governments in promoting the establishment of inter-firm agreements is very important. Governments can help promote inter-firm agreements by designing a regulatory framework to make sure that the rights and obligations of the partners are respected. Government policies can also facilitate the initiation and sustainability of technological partnerships by providing a forum for the exchange of information and for discussion, and by promoting and funding research and development projects. Governments can also assist in fostering technology partnerships by involving business associations and other relevant institutions and by paying greater attention to the "soft" issues of technology exchange and transfer, such as education and training. Education and basic research, especially in universities and training institutions, should to be strongly supported by the State.

27. Traditionally, cooperation in science and technology has evolved as a random process, sometimes based on the interests of the donor countries, sometimes on the scientific interests of influential scientific and technical institutions and at other times on the outcome of bilateral discussions. Experts emphasized that Governments need to spell out clear national strategies and goals for the development of science and technology if they are to forge effective technology policies.

28. International organizations and institutions can also play a major role in supporting the efforts of Governments in developing countries and in countries with economies in transition to promote partnerships with foreign private firms, especially transnational corporations. The successful establishment of partnerships also requires the active involvement of key economic actors such as industry and business associations to raise awareness and facilitate cooperation.

5. Partnerships and networking in the energy sector

29. Energy is vital for economic growth and social development. It is used to provide all the services that facilitate human endeavour from lighting, heating and air-conditioning through food and industrial production to communication and modern transportation. Yet poverty puts these modern energy services beyond the reach of nearly half of the total population in the developing countries. It is not surprising that meeting the energy needs of this large segment of the world's population has become a major preoccupation of economic planners and an issue of considerable political debate in most countries.

30. Experts pointed out that the provision of energy has traditionally been the responsibility of the State in most countries. Furthermore, ready access to modern energy supplies and services has come to represent both a basic policy goal and a measure of social and economic progress. In developing countries, most energy programmes and projects are still centrally driven and subsidized in many ways. Regarded as a strategic resource as well as a necessary public good, energy services have tended to be centrally planned and protected from market forces. Political and social considerations have encouraged Governments worldwide to provide large subsidies to insulate consumers from the true cost of provision.

31. In presenting some African experiences and lessons in partnering and networking in the energy sector, one of the experts recalled that as economic systems as well as international credit and donor policies, shift towards encouraging more sustainable and market-based activities, energy institutions are faced with the need to provide more efficient energy services within a competitive environment. Given their lack of capacity, knowledge-based institutions, particularly in Africa, increasingly face challenges and opportunities in establishing strategic networks and partnerships, which could substantially enhance their effectiveness. However, few knowledge-based institutions are in a position to respond to these challenges. Donor assistance can still play a significant role in building capacity in knowledge-based organization in the energy sector and in initiating effective networking and partnering activities.

5.1 Why energy partnerships are necessary

32. In the discussion on energy demand and its growth, it was noted that energy demand in developing countries is rising rapidly as a result of population growth and economic development. This burgeoning demand for energy creates shortages, particularly of electricity, that disrupt industrial growth and lower the quality of life. Moreover, the supply of energy depends, to a large extent, on systems that are unsustainable owing to the depletion of exhaustible fossil-fuel resources and the over-consumption of traditional energy sources such as fuel woods and biomass, which destroys forests and pollutes the atmosphere. While solutions to these problems are available, it will take many years to put them into effect; meanwhile, ignoring them can only have more negative effects for the environment. The objective now should be to accelerate the introduction and use of commercially viable renewable energy technologies in developing countries. Through partnerships, energy companies with the appropriate technology and expertise can play a positive role in helping developing countries to achieve this objective.

33. Given the growth in energy demand and the various financial considerations involved, the current business-as-usual way of dealing with energy means the outlook for developing countries is a bleak one of capital constraints, mounting debt, shortage of energy supplies and more serious environmental problems. Many countries already face such problems, and, with growing populations, the problem become worse. Therefore, a new, more feasible and sustainable approach to energy must be found. This was

recognized at the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992, but no coherent strategy to deal with the question was put in place. Therefore, if the objective of achieving a sustainable energy future is to be realized, Governments, industry and the private sector have to find more practical measures to make that happen. Partnerships and collaboration in energy technologies and capacity-building can help us to achieve that goal.

5.2 Scope and benefits of energy partnerships

34. There is perhaps no more pressing challenge facing the energy sector today than to provide energy - particularly to those who have no access to it - in ways that are consistent with addressing environmental concerns and sustainable development. Multilateral and bilateral assistance will undoubtedly help, but an enabling environment that includes incentives for energy investments and support mechanisms for partnerships with multinational energy companies will be necessary.

35. Partnerships in energy can provide a mechanism for countries to hedge the costs of complex and risky projects, which can be very high, particularly for long-term projects. They can also help improve national R&D capabilities, standardize methodologies and disseminate information on technology capabilities. The absence of partnerships could lead to a situation where a number of countries separately conduct costly research that may lead to similar results, and thus unnecessarily spend valuable research money that could be used elsewhere. Partnerships can help avoid duplication and unproductive research paths, as well as the development of advanced technology without an industry or a market for its use. Partnerships on energy projects provide a framework for experts on specific technologies to work together and exchange information on areas of mutual interest.

36. In discussing the different modes of partnerships in energy, participants noted that such partnerships have been formed by entities with different motivations: Governments propelled by the need to secure energy supplies, acquire technology, build indigenous capacity, promote renewable energy technologies and confront energy-induced environmental problems, and businesses enticed by investment opportunities. In the least developed countries, there have been a number of attempts to promote networks and partnerships in the energy sector. Many of these have been initiated and funded by donors. Many of the partnerships have been motivated by a need to enhance capacity, mostly through the sharing of public-domain information and experience, while others have not responded to local needs and aspirations.

37. One of the most important areas where international cooperation and partnerships are essential is global environmental protection. The international nature of many environmental problems requires an international response aimed at finding solutions to global, regional and local environmental problems such as greenhouse gases, acid rain and particulate emissions. The objective of the United Nations Framework Convention on Climate Change, for example, can only be achieved with the active participation and contribution of all States, which are parties to the Convention.[3]

38. Collaboration in energy technology R&D is another fundamental area of energy cooperation aimed at the improvement of the long-term security of energy supplies by promoting diversity, efficiency and flexibility within the energy sector. At present, there are a large number of agreements covering collaboration in energy research and development among member States of the International Energy Agency.[4]

39. Another significant form of international energy cooperation is participation of the foreign private sector in the provision of electricity

production and distribution in developing countries under sometimes complex but workable arrangements such as build-operate-trade (BOT) and build-own-operate (BOO) schemes. Such schemes shift the responsibility for financing, building and operating utility companies from the government to the private sector. Under a BOT arrangement, for example, a private company, or a joint venture with a minority equity participation of the host Government, is set up to raise funds, and plan, design and construct the power-generation facilities. The private company then operates the project facilities for a determined period, intended to be long enough to pay off debt and recoup an acceptable return on the investment. At the end of this period, ownership of the facilities is transferred to the host country. Among the potential benefits to be gained from BOT arrangements are the expertise and the advanced technology that independent power producers usually bring with them. In addition, the private investors bring financial capital to the project. However, because the legal, institutional and financial arrangements are usually complex, only a limited number of projects have been successfully launched. Developing countries that have benefited from such projects include China, India, Malaysia, Mexico and Thailand.

5.3 Some examples of energy partnerships

40. At government level, international collaboration and partnership agreements on energy technology are still largely confined to the industrialized countries, although their use has spread to a number of developing countries, particularly NICs. Asia Alternative Energy is an energy cooperation project created by the World Bank, with support from the Netherlands Ministry of Development Cooperation, the United States Department of Energy and other donors. Its mandate is to stimulate environmentally sustainable and commercially viable renewable energy and demand-side management in Asia. The project has already commissioned case studies of recent experiences in Indonesia, Sri Lanka and the Philippines and has identified key factors for successful residential photovoltaic programmes and ways to overcome the financial and institutional barriers to the use of solar power. It has provided insights into best practices to improve the prospects for successful project design and implementation.

41. An expert pointed out that a number of networks have been established through donor-funded activities with locally based institutions in Africa to facilitate the growth of local markets for photovoltaic and other renewable energy and energy-efficient technologies from developed countries. One such project is the Renewable Energy Information Network for Southern Africa, which has been funded by the European Commission. The network incorporates a number of policy analysis and advocacy institutions in southern Africa, as well as government energy departments, and provides databases and market-research activities. One of the experts voiced concerns that such marketing and supply-oriented projects are seldom sensitive to the needs of the local population or to demand-side issues or to questions of choice and affordability. One of their explicit initial aims is to provide information linkages to European manufacturers. Other similar networking and partnering projects have the same objectives, that is, they are more concerned with opening up markets for energy products from the developed countries than with alleviating poverty through the provision of affordable energy services to rural and unserved urban populations in developing countries.

42. Similar concerns have also been voiced with regard to many networks in Africa related to climate change. These networks are generally well funded through multilateral and bilateral development assistance programmes, but there is a real concern that instead of building capacity, the multiple-donor programmes in climate-change networks have actually diminished knowledge-generating activities in pressing areas of more relevance to the energy sector in Africa, by diverting the capacity of knowledge-based institutions from the core problems and challenges facing the sector, namely the role of energy in

poverty alleviation and in supporting economic development.

43. Clearly, such concerns neither diminish nor deny the importance of energy partnerships. When motives are spelt out and objectives clearly identified, partnerships can help local knowledge-based institutions to position themselves strategically and so respond efficiently to local needs and opportunities.

44. With the exception of the R&D being undertaken by international energy companies, research into energy technologies is still mainly a government-funded activity in many countries. However, a number of private institutions and firms have emerged as competent partners. A number of such need-driven strategic networks and partnerships, as well as joint ventures involving Governments, business and industry and covering a wide range of energy projects, have been established.[5]

45. Experts noted that international enthusiasm for partnerships and collaboration in energy technology reflects awareness of the benefits of relying more on renewable energy sources. These sources help to fill our energy needs, but their contribution could be much larger. Future expansion of renewable energy requires fundamental changes in policy and practice by Governments and businesses, including greater international collaboration, full environmental costing of conventional energy sources, and continuing R&D and pilot projects to reduce costs, improve performance and establish consumer confidence.

6. Partnerships and networks in biotechnology

46. The expert presenting the paper on biotechnology partnerships and networking pointed out that biotechnology is a term which has come to be familiar to most people, even though it has not been universally defined. According to one common definition, biotechnology is "the application of biological science to the manipulation and use of living things for human ends". According to another, similar definition, it is "the application of biological organisms, systems and processes based on scientific and engineering principles to the production of goods and services for the benefit of man".[6]

47. Even though the concept itself may date back to the 1950s, with the unravelling of the genetic code and recombinant DNA technology, biotechnology, as we know it today, is a by-product of the knowledge revolution that has characterized the world economy over the past decade or so. The scientific developments underpinning biotechnology across a wide range of industries, from agriculture and food production to health and pharmaceuticals, have been extraordinary both in speed and innovation. Pharmaceuticals, health and food production have been the ones most affected, but other industries are also benefiting from the extraordinary versatility of biotechnology. In the discussion on the potential contribution of biotechnology to economic development, it was pointed out that while the technology is very promising, it has evoked contrasting reactions and intense public debate, ranging from ideological reactions to exaggerated and often unrealistic expectations. There are also concerns over its environmental and health consequences and the appropriate legal and regulatory framework for the industry.

48. In some cases, Governments in developed countries have played a useful role in supporting the nascent biotechnology industry, but the vast majority of partnerships take place in the private sector, with no government involvement. Large pharmaceutical companies have entered into a number of inter-firm agreements with small biotechnological firms though R&D contracts, licensing agreements and minority shareholdings. The sharp increase in biotechnology inter-firm agreements has come about because scientists and managers have teamed up to tap into the potential of this field, which is

perceived as being one of the key technological areas for the future. In many cases, Governments have provided additional research grants and other support, including legal frameworks, with the objective of securing the competitiveness of domestic industry in this area.

6.1 How important are biotechnology partnerships?

49. Experts highlighted the importance of partnerships and networks in biotechnology in improving technological capabilities and making successful innovation possible. Alliances in pharmaceutical biotechnology abound. Cross-border biotechnology mergers are on the increase and biotechnology companies are increasingly becoming an integral part of the pharmaceutical industry. One of the aims of pharmaceutical companies now is to forge alliances with biotechnology companies for the provision of emerging technologies to help the pharmaceutical companies, who are spending a large share of their R&D budgets on taking equity stakes in biotechnology companies and in forging alliances with them.

50. Partnerships and networks in biotechnology innovations related to agriculture and food are less widespread than in the pharmaceutical industry, but are also important. The role of biotechnology in agriculture and food production is conditioned by the extent of the diffusion of the technology, which in turn, depends upon a number of factors, including technical feasibility, economic profitability, safety and public acceptance.

6.2 What can biotechnology offer developing countries?

51. Experts pointed out that while global food production has been rising, per capita food output has declined in a large number of low- and middle-income countries. In most sub-Saharan African countries and in the Middle East, the degree of self-sufficiency in grains, the most important food staples in the diets of these regions, has declined. Even in the most productive areas of cultivation in Asia, where intensive agriculture has been practised for many years, annual growth rates in yields per hectare of rice and wheat have also declined. According to the Food and Agriculture Organization of the United Nations (FAO), these trends are likely to continue well into the next century. The FAO expects that by 2010 a large number of developing countries that are net food exporters will have become net importers of agricultural products. Other developing countries in Latin America and the Caribbean, North Africa, West Asia, and the Pacific and Indian Ocean islands will also be affected. Further expansion of land for cultivation will be difficult in much of the developing world. This implies that future growth in food production will have to rely increasingly on higher yields. Innovation and technological upgrading, brought about by biotechnology, will be vital in making that happen.

52. It was noted that while biotechnology has much to offer developing countries trying to improve their food and agricultural output, large multinational companies are unlikely to make crops in poor developing countries the focus of their attention. In order to use, operate and adapt the technology to local conditions, developing countries will need to build indigenous capacity. A number of studies related to developing countries' attempts to build capacity in biotechnology have stressed the need to acquire technological capabilities through networks and partnerships. They have also stressed the need for links and interactions among the various actors, including private and public sector institutions, both national and international, and between government policies and market forces.

6.3 Trends in biotechnology partnerships and networking[8]

53. The potential benefits that biotechnology could bring to a wide range of industrial applications gave rise in the late 1970s and early 1980s to the

emergence of a large number of small biotechnology firms, particularly in the United States. Many of them were established in geographic clusters and located close to reputed universities in California and Massachusetts, for easy access to scientists and academics. Many of those firms were founded by scientists and venture capitalists seeking to marry scientific ideas with finance and management skills to generate income streams quickly. However, instead of generating profits and earnings, many generated losses and bankruptcies and instead of having products they had dreams. After the initial euphoria, which allowed many of those start-up firms to raise money to finance what has become known as a "burn rate" - the money they spend on R&D in the years prior to bringing a product to market and generating income - a process of takeovers and acquisitions gave large companies from various sectors control over many of those newly founded small biotechnology firms.[9]

54. That initial euphoria was brought about by the promise that biotechnology companies could develop drugs more quickly than large pharmaceutical corporations. That proved not to be the case. It took even the most successful companies the industry standard of about 10 years to deliver their first drug, in large part owing to regulatory hurdles. For example, it took Amgen, considered the most successful company in the history of the biotechnology industry, nine years to bring its first drug to market. With the notable exception of Amgen and Genzyme, few of the most successful biotechnology firms survived as independent entities in the 1980s and 1990s. Genentech, the second-largest biotechnology firm, was taken over by Hoffman La Roche, and Chiron, the fourth-largest, was acquired by Ciba-Geigy. Meanwhile, Amgen reinforced its position at the top of biopharmaceutical companies through its acquisition of Synergen. By the end of the decade, the large pharmaceutical firms had consolidated their positions through acquisitions and alliances, made easier by the financial difficulties that faced most of the smaller dedicated biotechnology firms.

55. As a result, throughout much of the 1980s, biotechnology played an increasingly important role in the pharmaceutical industry, as the big pharmaceutical companies began to tap into the flourishing innovation brought to them by biotechnology firms. The failure of many of those small dedicated biotechnology firms to survive as truly independent players suggests that technological skills alone do not guarantee successful economic and commercial operations. The amount of financial resources needed and, the inability to take advantage of economies of scale in R&D as well as in distribution and marketing can be serious constraints for new start-ups.[10]

56. Alongside those mergers and acquisitions, networked, knowledge-based biotechnology alliances and partnerships emerged. Prior to 1979, 62 technological agreements in biopharmaceuticals were finalized. In the period 1980-1984 this rose to 222 agreements and in 1985-1989 to 398 agreements. During this latter period, other biotechnology agreements were also signed, including 123 in agro-biotechnology, 89 in basic biotechnology research and 108 in other sub-fields of biotechnology, bringing the total number of agreements finalized in that period to 718, an increase of 83 per cent over the 1980-1984 period. Towards the end of the 1980s and in the early 1990s, there was a marked slowdown in the number of inter-firm biotechnology agreements signed. Since 1993, however, strategic alliances in biotechnology have picked up again as a result of more intense competition in an industry that has become international and more mature. Europe now has at least 500 biotechnology companies, of which about 50 are publicly traded. Alliances between big pharmaceutical companies and these European biotechnology companies are increasing. Cross-border biotechnology alliances and mergers are no longer a rarity. To the extent that these strategic alliances continue to take the form of North-North partnerships, there is a real concern that developing countries' firms will be left behind. Available evidence, however, suggests that biotechnology networks and partnerships, particularly in R&D, are also emerging rapidly in many developing countries.

6.4. International biotechnology initiatives in developing countries

57. Developing countries receive over 50 per cent of the financial commitment to international initiatives in biotechnology research programmes and networks, including international agricultural research centres, universities and national research organizations.[11] In addition, many developing countries participate regularly in policy workshops, including workshops on bio-safety and intellectual property rights, and attend training courses offered either in universities in developed countries or in international agricultural research centres located in developing countries. While over 60 developing countries are involved in these international biotechnology initiatives, most efforts are concentrated in a few countries within each geographical area: Côte d'Ivoire, Egypt, Kenya and Zimbabwe in Africa; India, Indonesia and Thailand in Asia; and Brazil, Costa Rica and Mexico in Latin America.

58. In one of the presentations it was stressed that while donor-funded biotechnology initiatives provide training opportunities for developing countries' scientists and engineers and can thus enhance national scientific and technological capabilities in agriculture, in most cases, developing countries have not been closely involved in the selection, planning or design process of those programmes. Rather, many of the initiatives were designed, and the research priorities determined, by scientists and managers from the donor countries. Only a few of the initiatives involve consultation at the grass-roots level with small farmers, for example - in their design and implementation.

59. In addition to these international biotechnology initiatives, a number of alliances and partnerships involving firms from developing countries emerged in both pharmaceutical and agricultural-related biotechnology, either in collaboration with local research institutions or in cooperation with foreign partners. Throughout much of the 1980s, a number of large firms in Argentina, Brazil, India, the Republic of Korea and Taiwan Province of China invested heavily in the nascent biotechnology industry. To face up to the challenge of competition and to remain at the technological frontier, some of those firms have become involved in partnering activities with other firms from both the North and the South. While such firms succeeded in crossing the barriers to entry increasingly being built by powerful, knowledge-based oligopolies in the North, the fact is that to date most of the biotechnology innovation and R&D, even that being undertaken in developing countries, is designed according to the priorities of developed countries and oriented towards their markets.

7. Conclusions

60. The Working Group meeting convened by the CSTD raised several policy issues for consideration by the different actors involved in the process of partnerships and networking. Among the broad policy questions considered were:

(a) Have we entered a new era of networks and partnerships, and have they have become an essential form of strategic interaction for firms?

(b) If so, under what conditions do they present new opportunities and constraints for firms from developing countries and countries in transition to build indigenous capacity and technological capability?

(c) What might Governments and the international community do to promote this process?

61. The available data support the view that we have indeed entered a new era of partnerships and alliances. The recent upsurge in inter-firm agreements brought about by globalization and accelerated by the emergence of a knowledge-based global economy is probably irreversible, at least in the foreseeable future. As we move into the next millennium, the process of partnering and networking will not simply be an option; it is likely to be an essential tool to maintain competitive lead. Firms and Governments alike will have to look outward and to each other and seek out new forms of collaboration and integration to face up to the challenges of globalization and not be left behind.

62. Although concerns were raised about the benefits or otherwise of partnerships and networking particularly in poor developing countries, there was agreement that partnerships and networking offer a valuable tool for developing national potential in science and technology. Partnerships and networking can be effective mechanisms to foster the generation, sharing and diffusion of scientific and technical knowledge. They can be a key to the transfer and exchange of technology, building indigenous capacity, fostering technological capability and improving competitiveness. They can also be extremely useful tools for firms in developing countries and countries in transition who wish to access international markets and enhance their export performance. By facilitating access to technologies and markets, inter-firm partnerships can potentially contribute to the more effective integration of developing countries into the world economy. Partnerships can also be vehicles to mobilize the funds and technological expertise needed to build and expand infrastructure. The least developed countries in particular lack the necessary financial and human resources to meet their burgeoning needs for energy supplies and services on their own. BOT and BOO agreements can help them to get power stations built to provide energy services to their rapidly growing populations.

63. All participants favoured inter-firm cooperation. They agreed that there is no formula for successful partnering and networking that can be applied universally in all situations. A critical factor in the success of a project, is the commitment of all partners at all levels. The success or failure of inter-firm cooperation depends on the specific situation and on the aims and objectives of the parties involved. Nevertheless, experience has revealed some of the general dynamics that make inter-firm agreements work. These include: (a) thorough preparation, that is, seeking information, identifying the right match and minimizing the risk of conflicts; (b) clarity and commonality of motives, that is, mutual agreement on precise objectives, and appropriate modes of governance; (c) the creation of the conditions for learning, that is, the exchange and training of personnel, building trust and introducing methods for monitoring and assessing the process; and (d) the completion of the "collaboration cycle", that is, ensuring that tangible benefits are achieved and, if not, deciding whether to continue with the collaboration.

64. Similarly, the benefits of partnering will not be the same for all countries. They will depend, *inter alia*, on existing conditions, such as specific local economic and social needs and the level of development of the enterprise sector in the host country. If they are to achieve their objectives of building indigenous capacity and facilitating access to capital, technology and markets, partnerships must be supported by active business associations and appropriate government policies that encourage the growth and success of inter-firm cooperation. It was emphasized that approaches to cooperation and partnerships, particularly in developing countries, should take into account the concerns of all actors and stakeholders in development, including those at the grass-roots level, Governments, firms, institutions and NGOs. It was also emphasized that partnerships have to be established equitably.

65. Governments have an important role to play in promoting partnerships and networking, particularly in developing countries. Recent studies on partnerships and networking reveal that the presence of an enabling environment which ensures a stable macroeconomic policy and a credible legal framework and which includes incentives and support mechanisms is of paramount importance to inter-firm cooperation. These are especially important because they affect foreign firms' incentives to enter into partnerships to which they will have to allocate large amounts of financial and technical resources. Governments also have an important role to play in supporting networks and cooperation between universities based on fair principles of balanced contributions. International and regional organizations as well as multilateral financial institutions also have a role to play in complementing the efforts of developing countries and countries in transition to promote partnerships and networking in science and technology.

66. Shedding light on the above issues and focusing attention on the critical importance of building indigenous capacity and technological capabilities as indispensable inputs to sustainable development in both developed and developing countries was one of the objectives of the CSTD in convening the meeting of the Working Group. There are currently a large number of collaboration agreements on biotechnology and on the sustainable use of energy in effect in developed countries and, to a lesser degree, in developing countries and economies in transition. There was agreement that international collaboration should involve more developing countries, where the demand for both food and energy is expected to rise dramatically over the coming decades. Providing adequate supplies of food and energy to meet these growing needs while at the same time safeguarding the natural environment will be a major challenge to policy makers worldwide. There are many opportunities for cooperation between developed and developing countries that would accelerate the development and use of sustainable energy technologies and biotechnology. For developing countries to leapfrog to a sustainable path of energy and food production, they need a strong indigenous capacity and technological capabilities to adapt, operate and develop advanced alternative technologies. Partnerships could help firms in developing countries and countries in transition to become integrated in the world economy. In many developing countries, firms, especially SMEs, do not have the necessary expertise, technological capacity or funds to pursue innovation on their own and to compete on a global scale.

8. Recommendations

67. The discussion at the meeting of the Working Group resulted in findings and recommendations in terms of policy options and initiatives that both developing countries and economies in transition could use to promote partnering and networking between firms. The following are some of the main findings and recommendations addressed to Governments:

(a) Create and maintain a stable macroeconomic and policy environment that includes incentives and support mechanisms which encourage investment and foster technological capabilities and industrial development;

(b) Prepare the ground for inter-firm cooperation through the creation of a forum for dialogue with private and public sector bodies, with a view to raising awareness about the potential benefits and critical role of inter-firm cooperation in building technological capacity and in promoting export growth;

(c) Identify, in cooperation with national business associations and knowledge-based institutions: (i) priority areas for the development of technological capacity, where international partnerships and networking could play and essential role; (ii) the major needs of

local firms in terms of technology, expertise and know-how, in order to map out clear objectives, expected output and monitoring tools; and (iii) useful services that could be provided to foreign firms interested in forming partnerships with domestic companies and that could help in establishing more equitable and balanced partnerships;

(d) Provide a stable legal and regulatory framework for business and inter-firm agreements and transactions, including the introduction of procedures that facilitate the clarification of any disputes and a system of property rights that protects both foreign and domestic firms willing to engage in partnerships;

(e) Provide support to foster partnerships between public and private institutions by contributing information and knowledge, harmonizing rules, financing the development of R&D activities and infrastructure, brokering between potential partners, and raising public awareness of the role and benefits of partnerships and networking in science and technology;

(f) Support partnerships and networking between academic institutions and provide the necessary means and infrastructure for basic research, with a view to enhancing indigenous capacity-building;

(g) Given the extent of burgeoning energy demand and financial considerations in developing countries, partnerships and collaboration on energy technologies have to increase in order to: (i) promote indigenous capacity-building in developing countries; (ii) provide modern energy services to rural and unserved urban populations through more use of renewable energy technologies; and (iii) encourage private sector participation in the provision of electricity supplies under innovative arrangements, such as BOT and BOO schemes.

68. Experiences in both developed and developing countries have revealed some of the factors and dynamics that lead to successful partnerships and networking. From these experiences, the CSTD, in cooperation with the secretariat, may wish to design a methodology based on best practices in inter-firm partnering and networking and develop criteria by which to measure their success, and to build an inventory of opportunities for international partnerships and networking in science and technology. In this connection, the results of the ongoing studies on guidelines for the successful performance of networks which are being carried out by experts on behalf of the CSTD, should be taken into consideration.

Notes

1. T. Tesfachew, "The role of governments in promoting inter-firm technology cooperation, paper published in ATAS XI Bulletin: *New Approaches to Science and Technology Cooperation and Capacity-Building* (United Nations publication, sales no. E.99II.D.4).

2. UNCTAD, *World Investment Report 1998: Trends and Determinants* (United Nations publications, sales no. E.98.II.D.5), p. 29.

3. United Nations Framework Convention on Climate Change, A/AC.237/18 (Part II)/Add.1 and Corr.1, United Nations, New York.

4. International Energy Agency, *International Energy Technology Collaboration: Benefits and Achievements* (Organisation for Economic Co-operation and Development (OECD), Paris, March 1996).

5. For a list of energy partnerships, refer to M. Hamdi, "International and regional partnerships in energy", paper published in ATAS XI Bulletin: *New Aapproaches to Science and Technology Cooperation and Capacity-Building*, (United Nations publication, sales no. E.99II.D.4).

6. A. T. Bull, G. Holt and M. D. Lilly, Biotechnology: International Trends and Perspectives (Organisation for Economic Co-operation and Development (OECD), Paris, 1982), p. 21.

7. J. Bunders, B. Haverkort, and W. Hiemstra, ed., *Biotechnology: Building on Farmers' Knowledge* (London and Basingstoke, Macmillan 1996), p. 2.

8. This section draws heavily on L. Mytelka, "New trends in biotechnology networking", *International Journal of Biotechnology*, vol. 1, no. 1 (1999), pp. 30-41.

9. C. Correa, "South-South dimensions for partnering, implementing strategic alliances in the biotechnology sector", a paper published in ATAS XI Bulletin: *New Aapproaches to Science and Technology Cooperation and Capacity-Building* (United Nations publication, sales no. E.99II.D.4).

10. Ibid.

11. C. Brenner, and J. Komen, "International initiatives in biotechnology for developing county agriculture: promise and problems", Technical Paper No. 100, produced as part of the research programme on International Policy Issues (OECD, Paris, 1994).

Annex I

List of Working Group members and experts

Working Group members:

Professor Dr. B.M. Rode	Austria
Dr. Galina Butovskaya	Belarus
Dr. Kouadio Amani	Côte d'Ivoire
Mr. Justo A. Quintero	Cuba
Dr. Asrat Bulbula	Ethiopia
Dr. Arnoldo K. Ventura	Jamaica
Ms. Jennifer Cassingena Harper	Malta
Mr. Alfred A. Van Kent	Namibia
Professor Joske F.G. Bunders	Netherlands
Dr. M.M. Zafar	Pakistan
Dr. Kong-Rae Lee	Republic of Korea
Ms. Rolanda Predescu	Romania
Mr. Ali Abaab	Tunisia
Dr. Titus Mteleka	United Republic of Tanzania

United Nations agencies

Professor B. Sayer	World Health Organization
Mr. Omar F. Bizri	Economic and Social Commission for Western Asia
Dr. Dirk Pilari	Department of Economic and Social Affairs
Dr. Ludovico Alcorta	United Nations University, Institute for New Technologies, Netherlands

Experts:

Dr. Nicholas S. Vonortas	Center for International Science and Technology Policy, Washington, DC, United States of America
Dr. Neils Busch	Busch & Partners, Copenhagen, Denmark
Professor Anton Eberhard	Economic and Development Review Committee - University of Cape Town, South Africa
Dr. Joanna Chataway	Biotechnology Policy Group, the Open University, United Kingdom

Annex II

List of background documents

"Building capacity in biotechnology: the role of networks and partnerships", by Joanna Chataway

"Strategic Alliances for Developing Countries", by Nicholas S. Vonortas

"Strategic knowledge-based partnering and networking for capacity building in the energy sector: some African experiences and lessons", by Anton Eberhard

"Partnerships for resource efficiency and technology transfer", by Dirk Pilari

"International and regional partnerships in energy", note by the UNCTAD secretariat

"Government policies for successful inter-firm technological collaboration: the experience of Mercosur countries", by Ludovico Alcorta

"North-South Research Partnerships", by Joske F.G. Bunders and Chandan Mukherjee